Useful Government Spending and the International Transmission of Fiscal Policy

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Abstract

This paper addresses the international transmission of fiscal policy, making use of a calibrated NOEM model. While most NOEM models assume that government spending does not affect productivity or private utility, we allow for productive and utility-enhancing government spending. First, we consider the role of government spending as an input to private production. Second, we allow for utility-enhancing government spending, by modelling private and government consumption as substitutes. The numerical solution of the model shows that a fiscal shock causes domestic and foreign output and consumption to move in opposite directions in the long run. As expected, the introduction of productive government spending has positive effects on domestic output and consumption, but it also has a positive effect on foreign consumption. We show that productive government spending mitigates the impact of a fiscal shock on the nominal and real exchange rate, but it reinforces the impact of a fiscal shock on the current account.

Keywords: New open economy macroeconomics, fiscal policy, local-currency pricing

JEL classification: F3, F4

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1 Introduction

How are fiscal expansions transmitted in open economies? Does a domestic fiscal expansion cause an increase or a decline in foreign production? How do the international effects of a fiscal expansion depend on the composition of public expenditures? Even though such questions are central to open economy macroeconomics, there is no common agreement on the answers. The aim of this paper is to examine the international effects of fiscal policy shocks and the channels through which the shocks are transmitted across countries. To address these issues, we develop a new open economy macroeconomic model based on the local-currency pricing (LCP) paradigm in which the prices of imported goods are temporarily rigid in the importing country's currency. The model is based on the models of Betts and Devereux (2000) and Senay (1998). We use a staggered price setting framework, which implies that it is not possible to obtain a closed-form solution to the model, and thus its calibrated and log-linearized version is simulated numerically. One advantage of the use of a staggered price setting framework is that it allows for richer dynamic effects of fiscal policy than those found in the models with simultaneous one-step-ahead pricing that are common in the literature.

Since the publication of the seminal Obstfeld-Rogoff model (1995) the field of open economy macroeconomics has witnessed the development of new models for the analysis of international policy transmission. Although the new open economy macroeconomics (NOEM)[1] has paid a lot of attention to the international transmission of economic shocks, those studies mostly focus on the transmission of monetary policy shocks. For example, as Kim and Roubini (2004, 11) highlight "there is lack of detailed studies on the effects of fiscal policy". In particular, they underline that "[t]he effects of fiscal policy on the current account and the real exchange rate in calibrated versions of these NOEM models are still waiting to be analyzed."

In most NOEM models, government spending is pure waste and it does not affect private utility or productivity. However, any role for fiscal policy requires that government spending is someway useful. One way to motivate government spending is to introduce government consumption that yields utility. In this paper, we allow for utility-enhancing government spending, by modelling private and government consumption as substitutes in private utility, as in Ganelli (2003).[2] Another way to motivate government spending is to assume government services that affect production. In this paper, we

[1] An excellent survey of the NOEM literature by Lane (2001) focuses completely on monetary policy issues. Lane and Ganelli (2003) survey more recent developments in the literature and also fiscal policy issues. Coutinho (2003) focuses completely on fiscal policy issues.

[2] The original idea of modelling private and government consumption as substitutes in private utility dates back to Bailey (1971, Ch 9).

allow for government spending that is a productive input for private producers, as in Barro (1990). This idea is commonly used in the economic growth literature. In open economy macroeconomics, however, the consequences of productive government spending on the international transmission of fiscal policy has been ignored.

A key issue that has been at the core of current research on open-economy modelling is the currency denomination of sticky prices (see e.g. Lane and Ganelli 2003). Obstfeld and Rogoff (1995) assume that prices are sticky in the currency of the producer. A central idea of producer currency pricing (PCP) is the traditional expenditure-switching role for the nominal exchange rate. Under PCP, the degree of exchange-rate pass-through to import prices is 1 and a country with a depreciating currency experiences a fall in the relative price of its exports which in turn causes a redirection of world expenditure in favour of its products. When preferences are identical across countries, all goods are freely tradable and exchange-rate pass-through to import prices is complete, the law of one price always holds for all goods and the real exchange rate is constant.

Motivated by the weak empirical support for the law of one price in internationally traded goods and the evidence of limited exchange-rate pass-through to import prices, Betts and Devereux (2000, 2001), Senay (1998) and others have preferred an alternative assumption. This class of models assumes the possibility of segmentation across countries allowing firms to charge different prices for the same good in home and foreign markets. This pricing-to-market (PTM) approach goes much further than simply assuming that firms can price discriminate across countries. As emphasized e.g. by Obstfeld and Rogoff (2000), in addition to PTM, this class of models also assumes that prices are sticky in each country in terms of local currency. PTM in combination with local-currency pricing (PTM-LCP) implies that exchange rate changes cause proportional short-run deviations from the law of one price.[3] When import prices are sticky in each country's local currency, the short-run degree of exchange-rate pass-through to import prices is zero. As is well known, the PTM-LCP approach implies "a radical rethinking of the traditional expenditure-switching role of exchange rates" (Obstfeld – Rogoff 2000, 122).[4]

As indicated above, the model we develop in this paper uses the PTM-LCP approach. This approach certainly has weaknesses as emphasized by Obstfeld and Rogoff (2000). Obstfeld (2002) goes one step further arguing that the assumption about PTM-LCP stems from oversimplified modelling strategy rather than from evidence. Whatever the truth, we adopt below a model in which prices are sticky in each country in terms of local currency.

[3] Engel and Rogers (2001) show that LCP explains a large part of deviations from the law of one price.

[4] Also Engel (2002) and Obstfeld (2002) discuss how LCP affects the expenditure switching effect of nominal exchange rate changes.

This assumption may not match reality exactly, but we believe that it is worth analyzing the international transmission of fiscal policy shocks in a model which is built on the PTM-LCP approach.

We show that the introduction of productive government spending increases the effectiveness of fiscal policy. The assumption of non-productive government spending, hence, leads to an underestimation of the effectiveness of fiscal policy. The main point of this paper could be that the composition of public expenditures matters. If public expenditures are used to finance public services that are inputs for private producers, the international effects of fiscal policy can be quite different than in the case where public expenditures are used to public consumption that is a close substitute for private consumption.

The rest of the paper is organized as follows. In Section 2 we lay out the model and derive the equilibrium conditions. In Section 3 we use the model to analyze the international transmission of fiscal policy. As hinted above, we emphasize the consequences of useful government spending. While most studies focus on the effects of permanent fiscal shocks, we also show how temporary fiscal shocks are transmitted. In this section, we also show that the quantitative effects of a fiscal shock on the real exchange rate and the international distribution of wealth are sensitive to the choice of some key parameter values. Finally, in Section 4 we provide some conclusions.

2 The Model

This section presents the framework used in the analysis, which is based on the models of Betts and Devereux (2000) and Senay (1998). Both papers develop a version of the Obstfeld-Rogoff model (1995), in which the two markets are segmented, allowing a fraction of firms to price discriminate across countries, and in which prices are sticky in the buyer's currency. In addition, Senay (1998) uses a staggered price setting framework. In the model developed here we assume that all firms can set different prices in different countries, all prices are sticky in the buyer's currency and that prices are set in a staggered fashion.

A difference between this model and that of Senay (1998) is in the structure of the financial market. In this model there is only one internationally traded bond, denominated in domestic currency [as in Betts and Devereux (2000)], while in her model households divide their bond holdings between domestic and foreign bonds. The main difference between this paper and that of Senay's is the aim of the analysis. She focuses the analysis on how increasing financial and goods market integration changes the effectiveness of fiscal and monetary policy and she represents the effects of fiscal policy only on a few domestic macroeconomic variables. Thus she completely ignores the analysis of the international transmission of fiscal policy which

forms the core of this paper.

An important precursor of this study is also the paper by Betts and Devereux (2001) which develops a staggered price setting model that uses the PTM-LCP approach. The main differences to Betts and Devereux (2001) are, first, that their model allows for capital accumulation while this model abstracts capital formation. Second, they allow for a distinction between the elasticity of substitution between goods within sectors and the elasticity of substitution between sectors (the elasticity of substitution between domestic and foreign goods).

In all above mentioned papers, government spending is assumed to be pure waste and does not affect productivity or private utility. We instead allow for useful government spending. First, government spending that may enter the production function as a factor of production that is complementary to labour. Second, government consumption can be a substitute for private consumption, as in Ganelli (2003). The main differences to Ganelli (2003) are that he assumes that prices are set one period in advance in terms of producers' currencies and that he obtains analytical solutions.

2.1 Households

The world is made of two countries, Home and Foreign, and is populated by a continuum of households. Each household produces a single differentiated good, indexed by z. We normalize the world size to 1 and consider that first n households reside in the Home country. All households have identical preferences. The utility function of a typical Home household is given by

$$U_t(z) = \sum_{s=t}^{\infty} \beta^{s-t} \left[\log\left(C_s + \eta G_s\right) + \frac{\chi}{1-\varepsilon} \left(\frac{M_s}{P_s}\right)^{1-\varepsilon} - \frac{\ell_s(z)^2}{2} \right]. \qquad (1)$$

In this equation C_t and G_t are private and government consumption baskets (to be defined below), η $(0 \leq \eta \leq 1)$ is the marginal rate of substitution between private and government consumption, M_t is nominal balances, P_t is the consumer price index (to be defined below), ε is the inverse of the consumption elasticity of money demand and ℓ denotes the labour supply. In equation (1) variable C is a real consumption index

$$C = \left[\int_0^1 c(z)^{\frac{\theta-1}{\theta}} dz \right]^{\frac{\theta}{\theta-1}},$$

where $c(z)$ is consumption of good z and θ (> 1) is the elasticity of substitution between differentiated goods. The government's composite consump-

tion is analogous

$$G = \left[\int_0^1 g(z)^{\frac{\theta-1}{\theta}} dz \right]^{\frac{\theta}{\theta-1}}.$$

The Home country CPI is

$$P_t = \left[\int_0^n p_t(z)^{1-\theta} dz + \int_n^1 p_t(z^*) dz \right]^{\frac{1}{1-\theta}}, \tag{2}$$

where $p(z)$ denotes the Home currency price of a Home-produced good z and $p(z^*)$ is the Home currency price of a Foreign good z.

A Foreign households's utility function is completely identical to that of a Home household. The Foreign country CPI is

$$P_t^* = \left[\int_0^n p_t^*(z)^{1-\theta} dz + \int_n^1 p_t^*(z^*) dz \right]^{\frac{1}{1-\theta}}, \tag{3}$$

where $p^*(z)$ is the Foreign currency price of a Home good z and $p^*(z^*)$ is the Foreign currency price of the Foreign-produced good.

The Home country's import and export price indexes, respectively, are defined as

$$b_t(z^*) = \left[\int_n^1 p_t(z^*)^{1-\theta} dz \right]^{\frac{1}{1-\theta}},$$

$$b_t^*(z) = \left[\int_0^n p_t^*(z)^{1-\theta} dz \right]^{\frac{1}{1-\theta}}.$$

For future reference, the Home terms of trade, the relative price of Home imports in terms of Home exports, can be expresses as

$$TOT_t = \frac{b_t(z^*)}{E_t b_t^*(z)}, \tag{4}$$

where E is the nominal exchange rate (the Home currency price of Foreign currency).

The budget constraint of a typical Home household is

$$M_t + \delta_t D_t = D_{t-1} + M_{t-1} + w_t \ell_t - P_t C_t + \pi_t - P_t \tau_t, \tag{5}$$

where M_t is the money holding at the beginning of the period and δ_t is the nominal price of a bond ($\delta = (1+R)^{-1}$, where R is the nominal Home interest rate). In addition, D_t denotes holdings of Home currency denominated nominal bonds, w is the nominal wage rate , π represents the nominal profits

of Home firms (Home households own Home firms and Foreign households own Foreign firms) and τ denotes per capita taxes.

There is an integrated world capital market and the only asset households trade is a nominal bond, denominated in Home currency. The aggregate asset-market-clearing conditions is thus given by $nD_t + (1-n)\,D_t^* = 0$. Then the budget constraint of a representative Foreign household is

$$M_t^* + \delta_t^* \frac{D_t^*}{E_t} = \frac{D_{t-1}^*}{E_t} + M_{t-1}^* + w_t^* \ell_t^* - P_t^* C_t^* + \pi_t^* - P_t^* \tau_t^*. \tag{6}$$

2.2 First-Order Conditions for the Typical Household's Problem

A typical Home household maximizes the utility function subject to the budget constraint, specified in equation (5). The first-order condition for optimal consumption is

$$\delta_t P_{t+1} \left(C_{t+1} + \eta G_{t+1}\right) = \beta P_t \left(C_t + \eta G_t\right). \tag{7}$$

This Euler equation states that the household's intertemporal consumption profile is chosen to smooth "effective consumption" (that is $C + \eta G$). The first-order condition governing the household's optimal labour supply can be written as

$$\ell_t = \frac{w_t}{\left(C_t + \eta G_t\right) P_t}. \tag{8}$$

Equation (8) ensures that the marginal disutility of labour equals the marginal utility of private consumption. This equation states that the optimal labour supply is a negative function of effective government consumption (ηG). The reason for this is that an increase in ηG decreases the marginal utility of private consumption, causing the household to consume more leisure and work less. Finally, the first-order condition for the household's money demand can be written as

$$\frac{M_t}{P_t} = \left[\chi \left(C_t + \eta G_t\right) \left(\frac{1}{1-\delta_t}\right)\right]^{\frac{1}{\varepsilon}}. \tag{9}$$

The preceding equation states that the optimal amount of money balances is a function of effective consumption. The reason for this is that an increase in ηG reduces the marginal utility of money balances, thus the household substitutes private consumption with real balances (Ganelli 2003).

A Foreign household's optimal labour supply is analogous to that of a Home household. In addition, a Foreign household's optimal consumption and money demand can be written as

$$\delta_t^* P_{t+1}^* \left(C_{t+1}^* + \eta G_{t+1}^*\right) E_{t+1} = \beta P_t^* \left(C_t^* + \eta G_t^*\right) E_t, \tag{10}$$

$$\frac{M_t^*}{P_t^*} = \left[\chi\left(C_t^* + \eta G_t^*\right)\left(\frac{1}{1-\frac{\delta^* E_{t+1}}{E_t}}\right)\right]^{\frac{1}{\varepsilon}}. \tag{11}$$

2.3 The Government

Assume that governments in both countries balance their budgets each period and finance their spending by means of non-distortionary taxes and seigniorage. The Home government budget constraint, expressed in per capita terms, is given by

$$G_t = \tau_t + \frac{M_t - M_{t-1}}{P_t}. \tag{12}$$

Government spending is assumed to follow a first-order autoregressive process

$$\hat{G}_t = \rho \hat{G}_{t-1} + shock.$$

In the preceding equation, ρ governs the persistence of a fiscal shock and the hat notation is used to represent the percentage deviations from the initial steady state. The Foreign country's budget constraint, government composite consumption and government spending are analogously defined.

2.4 Firms

2.4.1 Technology and Profits

If government consumption is not a substitute for private consumption, we consider the role of public services as an input to private production, as in Barro (1990). In this case, we assume that public services are publicly-provided private goods, which are rival and excludable. Thus, public services are not subject to congestion effects and the model abstracts from externalities associated with the use of public services. As pointed out by Barro (1990), the general idea of including public services a separate argument of the production function is that private inputs are not a close substitute for public inputs. We assume that the flow of public services that enter the production function corresponds to (per capita) government spending.

Each firm, with the total number normalized to unity, produces a differentiated good. The production function of Home firm z is (the situation of Foreign firms is completely analogous)

$$y_t(z) = \ell_t(z)\, G_t^{\alpha},$$

where $y_t(z)$ is the total output of firm z and parameter α (> 0) captures the degree of a positive effect that government spending induces on the firm's production. The production function exhibits constant returns to scale in ℓ but diminishing returns in G.

Total output is divided between output sold at the Home market, denoted by $x_t(z)$, and output sold at the Foreign market, denoted by $v_t(z)$. Firm z minimizes cost $w_t \ell_t(z)$ subject to the above technology. The nominal marginal cost is given by

$$MC_t = \frac{w_t}{G^{\alpha}}. \tag{13}$$

The profits of a Home firm are given by

$$\pi_t(z) = p_t(z) x_t(z) + E_t p_t^*(z) v_t(z) - w_t \ell_t(z). \tag{14}$$

The first term on the right hand side is revenues from Home sales and the second term is revenues from Foreign sales. The total output of a Foreign firm is divided between output sold at the Home market, denoted by $v_t^*(z^*)$, and output sold at the Foreign market, denoted by $x_t^*(z^*)$. The profits of a Foreign firm are given by

$$\pi_t^*(z^*) = p_t^*(z^*) x_t^*(z^*) + \frac{p_t(z^*) v_t^*(z^*)}{E_t} - w_t^* \ell_t^*(z^*). \tag{15}$$

Given composite consumption indexes and integrating demand for good z across all households, we see that the demand functions for a typical Home firm's output are given by

$$x_t(z) = \left(\frac{p_t(z)}{P_t}\right)^{-\theta} (nC_t + nG_t),$$

$$v_t(z) = \left(\frac{p_t^*(z)}{P_t^*}\right)^{-\theta} [(1-n) C_t^* + (1-n) G_t^*].$$

These equations represent goods market clearing conditions for a typical Home firm in Home and Foreign market, respectively. Analogously, the demand functions for a typical Foreign firm in Home and Foreign market, respectively, are given by

$$v_t^*(z^*) = \left(\frac{p_t(z^*)}{P_t}\right)^{-\theta} (nC_t + nG_t),$$

$$x_t^*(z^*) = \left(\frac{p_t^*(z^*)}{P_t^*}\right)^{-\theta} [(1-n) C_t^* + (1-n) G_t^*].$$

Making use of goods market clearing conditions, the profit functions of a typical Home and Foreign firm can be written as

$$\begin{aligned} \pi_t(z) \quad = \quad & \left[\left(\frac{p_t^*(z)}{P_t^*}\right)^{-\theta} [(1-n) C_t^* + (1-n) G_t^*]\right] (E_t p_t^*(z) v_t(z) - MC_t) + \\ & \left[\left(\frac{p_t(z)}{P_t}\right)^{-\theta} (nC_t + nG_t)\right] (p_t(z) - MC_t), \end{aligned} \tag{16}$$

$$\pi_t^*(z^*) = \left[\left(\frac{p_t^*(z^*)}{P_t^*}\right)^{-\theta}\left[(1-n)C_t^* + (1-n)G_t^*\right]\right](p_t^*(z^*) - MC_t^*) + \left[\left(\frac{p_t(z^*)}{P_t}\right)^{-\theta}(nC_t + nG_t)\right]\left(\frac{p_t(z^*)}{E_t} - MC_t^*\right).$$

2.4.2 Staggered Price Setting

We assume that firms set prices in a staggered fashion, as in Calvo (1983). But before turning to staggered adjustment, we first examine the optimal price setting under complete price flexibility. Since monopoly firms can price-discriminate across countries, that are free to set different prices across countries to maximize profits. However, given the profit function [equation (16)], a profit maximizing Home firm ends up choosing prices that are a constant markup over marginal costs

$$p_t(z) = E_t p_t^*(z) = \frac{\theta}{\theta - 1} MC_t$$

such that the law of one price holds. The price setting problem facing a typical Foreign firm is also identical to that of a Home firm, and it chooses prices that are a constraint markup over Foreign marginal costs.

In the short run, prices are sticky. Following Calvo (1983) we assume that each firm resets its price in any given period with probability $1-\gamma$, independently of time elapsed since the last price adjustment. Each firm has to take this into account when setting its profit-maximizing price that there is a probability $0 < \gamma < 1$ that it cannot revise its price setting decision made in period s ($s < t$) in period t. When setting a new price in period t, firm z seeks to maximize the present value of profits weighting future profits by the probability that the price will still be effective in period s. Thus a typical Home firm seeks to maximize

$$\max_{p_t(z), p_t^*(z)} V_t(z) = \sum_{s=t}^{\infty} \gamma^{s-t} \zeta_{t,s} \pi_t(z),$$

where $\zeta_{s,t} = \Pi_{j=s}^{t}(1+R_j)^{-1}$ is the Home nominal discount factor. The optimal price setting strategy for a Home firm is to set the following prices

$$p_t(z) = \left(\frac{\theta}{\theta-1}\right)\frac{\sum_{s=t}^{\infty}\gamma^{s-t}\zeta_{t,s}(C_s+G_s)\left(\frac{1}{P_s}\right)^{-\theta}MC_s}{\sum_{s=t}^{\infty}\gamma^{s-t}\zeta_{t,s}(C_s+G_s)\left(\frac{1}{P_s}\right)^{-\theta}}, \tag{17}$$

$$p_t^*(z) = \left(\frac{\theta}{\theta-1}\right)\frac{\sum_{s=t}^{\infty}\gamma^{s-t}\zeta_{t,s}(C_s^*+G_s^*)\left(\frac{1}{P_s^*}\right)^{-\theta}MC_s}{\sum_{s=t}^{\infty}\gamma^{s-t}\zeta_{t,s}(C_s^*+G_s^*)\left(\frac{1}{P_s^*}\right)^{-\theta}E_t}. \tag{18}$$

Equation (17) is the profit maximizing Home currency price of a good sold in the Home country and equation (18) governs the profit maximizing Foreign currency price of a good sold in the Foreign country. The price setting problem facing Foreign firms is again identical to that of a Home firm. The optimal Home currency price of a Foreign good sold in the Home country and Foreign currency price of a good sold in the Foreign country are, respectively

$$p_t(z^*) = \left(\frac{\theta}{\theta-1}\right) \frac{\sum_{s=t}^{\infty} \gamma^{s-t} \zeta_{t,s}^* (C_s + G_s) \left(\frac{1}{P_s}\right)^{-\theta} w_s^*}{\sum_{s=t}^{\infty} \gamma^{s-t} \zeta_{t,s}^* (C_s + G_s) \left(\frac{1}{P_s}\right)^{-\theta} / E_t}, \tag{19}$$

$$p_t^*(z^*) = \left(\frac{\theta}{\theta-1}\right) \frac{\sum_{s=t}^{\infty} \gamma^{s-t} \zeta_{t,s}^* (C_s^* + G_s^*) \left(\frac{1}{P_s^*}\right)^{-\theta} w_s^*}{\sum_{s=t}^{\infty} \gamma^{s-t} \zeta_{t,s}^* (C_s^* + G_s^*) \left(\frac{1}{P_s^*}\right)^{-\theta}}. \tag{20}$$

We can use equation (17) - (20) to obtain difference equations describing the evolution of the optimal prices. After some algebra, one can get

$$\hat{p}_t(z) = \beta\gamma \hat{p}_{t+1}(z) + (1-\beta\gamma)\hat{MC}_t, \tag{21}$$

$$\hat{p}_t^*(z) = \beta\gamma \hat{p}_{t+1}^*(z) + (1-\beta\gamma)\left(\hat{MC}_t - \hat{E}_t\right), \tag{22}$$

$$\hat{p}_t(z^*) = \beta\gamma \hat{p}_{t+1}(z^*) + (1-\beta\gamma)\left(\hat{MC}_t^* + \hat{E}_t\right), \tag{23}$$

$$\hat{p}_t^*(z^*) = \beta\gamma \hat{p}_{t+1}^*(z) + (1-\beta\gamma)\hat{MC}_t^*. \tag{24}$$

We denote percentage changes from the initial steady state by hats, thus, for any variable $\hat{X}_t \equiv dX_t/\bar{X}_0$, where $\bar{X}_0$ is the initial steady-state value. For example, equation (22) governs the optimal price adjustment rule for a Home good sold at the Foreign market, in terms of Foreign currency. Equations (21)-(24) emphasize the forward looking nature of inflation. Firms that are re-setting their prices recognize that the prices that they set will remain effective for more than one period. As a result, firms find it optimal to take into account their expectations regarding the future exchange rate (if goods are sold abroad) and marginal costs, instead of looking at the current exchange rate and marginal costs only.

2.5 A Symmetric Steady State

All firms in the country are symmetric, which implies that they set the same output and when resetting prices in any given period they choose the same price. Each period a measure of $1-\gamma$ of the firms reset their prices while a fraction γ keep their prices unchanged. Thus we can rewrite the Home and Foreign country CPIs, equations (2) and (3), as

$$P_t = \left[n(1-\gamma) \sum_{s=t}^{\infty} \gamma^{s-t} p_{t-s}(z)^{1-\theta} + (1-n)(1-\gamma) \sum_{s=t}^{\infty} \gamma^{s-t} p_{t-s}(z^*)^{1-\theta} \right]^{\frac{1}{1-\theta}},$$

$$P_t^* = \left[n\left(1-\gamma\right) \sum_{s=t}^{\infty} \gamma^{s-t} p_{t-s}^* \left(z\right)^{1-\theta} + \left(1-n\right)\left(1-\gamma\right) \sum_{s=t}^{\infty} \gamma^{s-t} p_{t-s}^* \left(z^*\right)^{1-\theta} \right]^{\frac{1}{1-\theta}}.$$

Following previous work we consider the special case of zero net Foreign assets and equal government spending levels. In addition, in this steady state all exogenous variables are constant. Constant consumption implies that the steady-state world interest rate is tied down by consumption Euler equations (7) and (10): $\beta = \bar{\delta} = \left(1+\bar{R}\right)^{-1}$, where steady-state values are marked by overbars.

The consolidated budget constraint of the Home economy is derived by using equation (5), the government budget constraint (12) and the profits of a Home firm (14). It can be written as

$$\delta_t D_t = D_{t-1} + p_t\left(z\right) x_t\left(z\right) + E_t p_t^*\left(z\right) v\left(z\right) - P_t C_t - P_t G_t.$$

Analogously, the consolidated budget constraint of the Foreign economy is derived by using corresponding Foreign equations together with the asset-market-clearing condition

$$-\frac{n}{1-n}\delta_t^* \frac{D_t}{E_t} = -\frac{n}{1-n}\frac{D_{t-1}}{E_t} + p_t^*\left(z^*\right) x_t^*\left(z^*\right) + \frac{p_t\left(z^*\right) v_t^*\left(z^*\right)}{E_t} - P_t^* C_t^* - P_t^* G_t^*.$$

2.6 A Log-Linearized Model

The model is log-linearized around the initial symmetric steady state with $\bar{D}_0 = \bar{D}_0^* = 0$ and $\bar{G}_0 = \bar{G}_0^* = 0$. The linearization is implemented by expressing the model in terms of percentage deviations from the initial steady state. Those variables whose initial steady-state value is zero are normalized by consumption. Equilibrium of the log-linear version of the model can be described by the following equations

$$\hat{\delta}_t + \hat{P}_{t+1} + \hat{C}_{t+1} + \eta\hat{G}_{t+1} = \hat{P}_t + \hat{C}_t + \eta\hat{G}_t \tag{25}$$

$$\hat{\delta}_t^* + \hat{P}_{t+1}^* + \hat{C}_{t+1}^* + \eta\hat{G}_{t+1}^* + \hat{E}_{t+1} = \hat{P}_t^* + \hat{C}_t^* + \eta\hat{G}_t^* + \hat{E}_t \tag{26}$$

$$\hat{\ell}_t = \hat{w}_t - \hat{C}_t - \eta\hat{G}_t - \hat{P}_t \tag{27}$$

$$\hat{\ell}_t^* = \hat{w}_t^* - \hat{C}_t^* - \eta\hat{G}_t^* - \hat{P}_t^* \tag{28}$$

$$\hat{M}_t - \hat{P}_t = \frac{1}{\epsilon}\hat{C}_t + \frac{\eta}{\varepsilon}\hat{G}_t + \frac{\beta\hat{\delta}_t}{\epsilon\left(1-\beta\right)} \tag{29}$$

$$\hat{M}_t^* - \hat{P}_t^* = \frac{1}{\epsilon}\hat{C}_t^* + \frac{\eta}{\varepsilon}\hat{G}_t^* + \frac{\left(\hat{\delta}_t^* + \hat{E}_{t+1} - \hat{E}_t\right)\beta}{\epsilon\left(1-\beta\right)} \tag{30}$$

$$\beta\hat{D}_t = n\left(\hat{x}_t\left(z\right) + \hat{b}_t\left(z\right)\right) + \left(1-n\right)\left(\hat{E}_t + \hat{v}_t\left(z\right) + \hat{b}_t^*\left(z\right)\right) - \hat{D}_{t+1} - \hat{P}_t - \hat{C}_t - \hat{G}_t \tag{31}$$

$$\hat{y}_t = \hat{\ell}_t + \alpha \hat{G}_t \tag{32}$$

$$\hat{y}_t^* = \hat{\ell}_t^* + \alpha \hat{G}_t^* \tag{33}$$

$$\hat{x}_t(z) = -\theta\left(\hat{b}_t(z) - \hat{P}_t\right) + \hat{C}_t + \hat{G}_t \tag{34}$$

$$\hat{v}_t(z) = -\theta\left(\hat{b}_t^*(z) - \hat{P}_t^*\right) + \hat{C}_t^* + \hat{G}_t^* \tag{35}$$

$$\hat{v}_t^*(z^*) = -\theta\left(\hat{b}_t(z^*) - \hat{P}_t\right) + \hat{C}_t + \hat{G}_t \tag{36}$$

$$\hat{x}_t^*(z^*) = -\theta\left(\hat{b}_t^*(z^*) - \hat{P}_t^*\right) + \hat{C}_t^* + \hat{G}_t^* \tag{37}$$

$$\hat{y}_t = n\hat{x}_t + (1-n)\hat{v}_t \tag{38}$$

$$\hat{y}_t^* = n\hat{x}_t^* + (1-n)\hat{v}_t^* \tag{39}$$

$$\hat{G}_t = \rho \hat{G}_{t-1} + shock \tag{40}$$

$$\hat{G}_t^* = \rho \hat{G}_{t-1}^* + shock^* \tag{41}$$

$$\hat{P}_t = n\hat{b}_t(z) + (1-n)\hat{b}_t(z^*) \tag{42}$$

$$\hat{P}_t^* = n\hat{b}_t^*(z) + (1-n)\hat{b}_t^*(z^*) \tag{43}$$

where

$$\hat{b}_t(z) = (1-\gamma)\sum_{s=t}^{\infty}\gamma^{s-t}\hat{p}_s(z) \Rightarrow \hat{b}_t(z) = \gamma\hat{b}_{t-1}(z) + (1-\gamma)\hat{p}_t(z) \tag{44}$$

$$\hat{b}_t^*(z) = \gamma\hat{b}_{t-1}^*(z) + (1-\gamma)\hat{p}_t^*(z) \tag{45}$$

$$\hat{b}_t(z) = \gamma\hat{b}_{t-1}(z^*) + (1-\gamma)\hat{p}_t(z^*) \tag{46}$$

$$\hat{b}_t^*(z^*) = \gamma\hat{b}_{t-1}^*(z^*) + (1-\gamma)\hat{p}_t^*(z^*) \tag{47}$$

Equations (25) - (30) represent the log-linearized versions of the first-order conditions for the typical households‘ problem. Equation (31) is the log-linearized version of the consolidated budget constraint, equations (32) and (33) are the production functions and equations (34)-(37) are the demand curves. Equations (38) and (39) are log-linear versions of the (population-weighted) composition of Home and Foreign aggregate output, respectively. Equations (40) and (41) govern government spending. Equations (42) and (43) govern the evolution of Home and Foreign CPIs, respectively.

28 variables remain to be determined $C, C^*, P^*, \delta, \delta^*, \ell, \ell^*, w, w^*, D, x(z)$, $v(x), x^*(z^*), v^*(x^*), y, y^*, p(z), p^*(x), p^*(z^*), p(x^*), b(z), b^*(z), b^*(z^*), b(x^*)$, E, G and G^*. The 28 equations that jointly determine them are (21) - (47) and the log-linear version of the asset-market-clearing condition. Note that the Foreign consolidated budget constraint is left out because one equation is redundant by Walras' law.

3 The International Transmission of Fiscal Shocks

3.1 Calibration

Much of the quantitative analysis that follows relies on a baseline calibration of the model. In order to numerically solve the model, we use the method developed by Klein (2000) and software written by McCallum (2001).[5] The calibration of the model is fairly standard and follows Sutherland (1996). The main assumptions underlying the calibration are as follows. The elasticity of substitution between differentiated goods θ is set to 6, a value consistent with a 20 percent mark-up in the steady state. The subjective discount factor β is set to 1/1.05. Parameter γ, the probability of not adjusting prices in any given period, is set equal to 0.5. This implies an average delay between price adjustments of two periods. In the baseline calibration, we set $\varepsilon = 9$ which implies a rather low consumption elasticity of money demand $(1/\varepsilon)$. The two counties are of equal size, and thus n is set to 0.5. Parameter ρ is set to one (zero) if government spending shocks are permanent (temporary).

In addition, to highlight the consequences of useful government spending, we need parameter values for η and α. Aschauer's (1989) estimates of the degree of substitutability between private and government consumption are in the range of 0.23 to 0.42. Our choice of the marginal rate of substitution between private and government consumption is 0.3. We use the estimate of the output elasticity of public capital as a proxy for the positive effect that government spending exerts on the firms' production. Ai and Cassou's (1995) estimates of the output elasticity of public capital are in the range of 0.15 to 0.26. We set $\alpha = 0.2$.

3.2 Permanent Government Spending Shocks

3.2.1 Productive Government Spending

We begin by discussing the dynamic effects of an unanticipated permanent increase in Home government spending on a number of economic variables. We consider two alternative cases, in one case government spending affects productivity but not utility and in the other case government spending is pure waste (government spending does not affect productivity or utility). Figures 1, 2 and 3 illustrate the impulse responses to a 1 percent unilateral increase in Home government spending. In Figures, the horizontal axes show time and the vertical axes show the variables‘ percentage deviations from the initial steady state.[6] In addition, the CPI-based real exchange rate is

[5] I am grateful to Christian Pierdzioch for providing some Matlab code.

[6] Since those variables, whose initial steady-state value is zero are normalized by consumption, home bond holdings show deviation as a percentage of initial consumption level.

defined as

$$\text{Real exchange rate} = \frac{E_t P_t^*}{P_t}.$$

As can be seen from Figure 1, the rise in Home government spending causes Home and Foreign output and consumption to move in the same direction immediately after the shock. In the long run, Home consumption falls and Foreign consumption rises, so that the cross country comovement of consumption levels is negative. The rise in Home government spending increases the demand for both Home and Foreign goods, but domestic households are forced to foot the taxes that finance it. Higher taxes lead to an immediate fall in Home consumption, but because households respond by substituting into work out of leisure at the same time, the net effect on world aggregate demand is positive.

As expected, the introduction of productive government spending has a positive effect on Home output. When public services enter into the production function, government spending has a direct positive effect on Home output. At the same time, productive government spending decreases the marginal costs of Home firms allowing the firms to sell their products at lower prices.

The nominal exchange rate depreciates because the relative consumption change lowers the relative demand for Home money. If government spending is productive, the relative consumption change is smaller and consequently the nominal exchange rate depreciates by less. As shown by Betts and Devereux (2000), under LCP, exchange rate overshooting can occur in response to economic shocks.[7] Panel (e) in Figure 1 highlights that the nominal exchange rate overshoots its long-run level. As in Betts and Devereux (2000), exchange rate overshooting (undershooting) occurs in response to a fiscal shock if the consumption elasticity of money demand is smaller (greater) than one. The interest rate must fall to clear the Home money market and a fall in the Home interest rate is possible if the exchange rate is expected to appreciate. The exchange rate, therefore, has to overshoot its long-run equilibrium inducing an interest-rate differential that equals the expected rate of appreciation.

When prices are sticky and denominated in the currency of the buyer, the movement in the nominal exchange rate translates into a real depreciation. If government spending is productive, due to a smaller nominal exchange rate depreciation the real exchange rate depreciates by less. As prices can be adjusted, the real exchange moves back towards its original level. The assumption of identical consumption baskets together with the law of one price (under flexible prices) implies a constant real exchange in the long run.

[7] In the Obstfeld-Rogoff model, the nominal exchange rate jumps immediately to its long-run level. Also in Sutherland's (1996) calibrated model, which intoduces staggered price setting into the Obstfeld-Rogoff model, the nominal exchange rate makes a once-and-for-all step change in response to monetary and fiscal shocks.

To the extent that some firms cannot adjust their prices, there is no exchange-rate pass-through to import prices and thus the depreciation of the nominal exchange rate does not affect the relative price of Home and Foreign goods in either country. Consequently, the assumption about full LCP diminishes the expenditure switching effect associated with unexpected changes in the nominal exchange rate. In the case of LCP, exchange rate movements, instead of altering relative prices, have important implications for the revenues of firms [recall equations (14) and (15)]. When firms price their goods in terms of local currency, the depreciation raises the revenues of Home firms measured in Home currency terms, and reduces the revenues of Foreign firms measured in Foreign currency terms, at given production levels. Therefore, the depreciation causes a redistribution of income towards the Home economy and this effect raises Home consumption relative to Foreign consumption. However, this effect is more than offset by higher taxes and thus this effect only diminishes the fall in Home consumption.

Although the exchange-rate pass-through to import prices is zero among the firms that cannot adjust their prices immediately after the shock, there is still a small expenditure-switching impact of the exchange rate depreciation. This is due to the fact that optimal prices for goods that are sold abroad change when the exchange rate fluctuates. To the extent that firms can reset their prices, the exchange rate deprecation changes optimal prices immediately after the shock [recall equations (22) and (23)].[8] As panels (c) in Figures 2 and 3 displays, although Home firms will experience an increase in their marginal costs it is optimal to lower the Foreign currency price of goods sold at the Foreign market. The change in the relative price of imported to Foreign goods leads to the reallocation of consumption.

Panel (g) in Figure 1 shows some wealth accumulation by Foreign households immediately after the shock and that productive government spending reinforces the impact of a fiscal shock on the bond holdings of Foreign households. Foreign output increases in the short run. Therefore, to smooth consumption, Foreign households save and lower current consumption. Panel (d) displays that if government spending is productive a fiscal shock induces a greater tilt in the path of output. Thus, Foreign households accumulate more wealth. A permanent improvement in the bond holdings of Foreign households implies allows for a permanent trade balance deficit which is financed by a services balance surplus. This trade balance deficit make possible higher Foreign consumption.

As can be seen from panel (h), the Home terms of trade deteriorates. The reason for the deterioration is the increase in relative Home output. Lower wealth via the current account leads to some increase in work effort, but the main reason for the increase in Home output is the higher tax burden.

[8] Panels (c) and (d) in Figures 2 and 3 show how optimal prices are affected by the changes in the nominal exchange rate and nominal wages.

The negative wealth effects increase relative Home output thus causing a permanent deterioration in its terms of trade. If government spending is productive, the Home terms of trade deteriorates by more because Home firms sell their extra production at lower prices.

Panel (c) in Figure 1 shows that the influence of productive Home government spending on Foreign consumption is positive. The reason behind this is that when government spending is productive both higher Foreign wealth and the improvement in the Foreign terms of trade allow Foreign households to increase their consumption. A closer look at Panel (d) reveals that a fiscal shock is predicted to slightly decrease Foreign output in the new steady state. The reason is that with higher wealth (consumption), Foreign households shift out of work into leisure. Panel (d) also reveals that the introduction of productive government spending has a negative spillover effect on Foreign output in the long run. Higher consumption, which pushes Foreign households to consume more leisure, explains why the consequence of productive Home government spending on Foreign consumption is negative in the long run. However, this impact is certainly very small.

We would like to highlight two features of the responses shown in Figure 1. First, the spillover effects of Home fiscal policy on the Foreign economy seem to be fairly small in the long run, with the exception that the composition of production changes as the country's export sector expands.[9] The effects of Home fiscal policy on the Foreign country are substantially smaller than those reported by Betts and Devereux (2001). As mentioned, a fiscal shock slightly decreases Foreign output in the long run. Hence, the model predicts a negative cross country comovement of output levels in the long run, as in Betts and Devereux (2001). Second, it is worth observing that a rise in government spending induces a substantially smaller increase in Home output than in the model of Betts and Devereux (2001), even though we allow for productive government spending. The main reason for the difference is that, in their model, a fiscal policy shock leads to a large increase in investment.

The analysis of this section demonstrates that the qualitative effects of fiscal policy are not sensitive to the introduction of productive government spending. All macroeconomic variables move qualitative in the same way, in response to a permanent fiscal shock. The consequences of productive government spending on the macroeconomic variables are purely quantitative. The cynical reader might conclude from this that the introduction of useful government spending is not necessary. A more appropriate conclusion would be that in analyzing the international effects of fiscal policy it is important to take into account the composition of government expenditures. Moreover, if

[9] The result, that a Home fiscal shock greatly changes the composition of Foreign output although the impact on aggregate output is next to nothing, suggests that a lot of information is lost, if we concentrate the analysis only on the macroeconomic effects of fiscal policy.

public services are productive inputs for private firms, then the assumption of non-productive government spending leads to an underestimation of the effectiveness of fiscal policy.

3.2.2 Utility-Enhancing Government Spending

We now turn to the consequences of utility-enhancing government spending and consider the same unanticipated permanent rise in Home government spending equal to 1 percent (of initial consumption). Figure 4 shows the dynamic effects of a Home fiscal shock on macroeconomic variables. As before, we consider the case in which government spending is pure waste as a benchmark to illustrate the consequences of the assumption $\eta > 0$.

Figure 4 displays that the introduction of utility-enhancing government spending tends to have negative effects on Home consumption and output. These effects are the same as in Ganelli (2003) and for the same reason. The reason is direct crowding-out: the fact that private and government consumption are substitutes has a direct crowding-out effect on private consumption (Ganelli 2003, 99). When private and government consumption are substitutes the fall in private consumption is bigger than in the pure waste case and the positive effect of a fiscal shock on output is decreasing in η. An increase in ηG raises Home leisure in every period because it reduces the marginal utility of private consumption and consequently households are less willing to supply labour [recall equation (8)]. This also explains why the Home terms of trade deteriorates by less than in the case of pure waste. A fall in the supply of Home goods raises their relative price.

Figure 4 shows that the introduction of utility-enhancing government spending has a negative effect on Foreign consumption and output in the short-run. In the short-run, as in Ganelli (2003), the reduction in Home consumption due to direct crowding-out decreases the demand for Foreign goods, reducing Foreign output and consumption relative to the pure waste case. In the long-run, the output spillover becomes positive, if only the magnitude of the change in Foreign output is next to nothing. As Panel (e) shows the introduction of utility-enhancing government spending mitigates the response of bond holdings of Home households which implies that the net wealth of Foreign households increases by less than in the pure waste case. This pushes Foreign households to consume less leisure and work more.

The main differences between the results of this model and those of Ganelli (2003) can be found from the long-run spillover effects. In Ganelli (2003), the introduction of utility-enhancing government spending has an ambiguous effect on Foreign long-run consumption and a negative effect on Foreign output. In this model, for the reason discussed above, the introduction of utility-enhancing government spending increases Foreign output, relative to the pure waste case. In addition, utility-enhancing government spending has a negative effect on Foreign consumption. The reason is that,

unlike in Ganelli (2003), the international distribution of wealth increases Foreign consumption and lower its output. If government spending yields utility, the increase in Foreign wealth is smaller. Consequently Foreign households have less money for consumption and they also increase their labour supply.

As Panel (d) in Figure 4 points out the introduction of utility-enhancing government spending mitigates the real exchange rate depreciation due to a smaller nominal exchange rate depreciation. As emphasized by Ganelli (2003), the direct and indirect effects on money demand pull in opposite directions. The direct effect is caused by the relative consumption change which tends to lower the relative demand for Home money. The indirect effect is caused by the fact that money demand is now also a positive function of effective government consumption [recall equation (9)], which tends to raise Home money demand. The indirect effect dominates insomuch that the nominal exchange rate depreciates by less than in the pure waste benchmark.

The analysis of this section demonstrates that the consequences of utility-enhancing government spending in this model are very identical to the findings of Ganelli (2003). As mentioned, however, this is model utility-enhancing government spending has a positive effect on Foreign consumption, for the reason discussed above. New findings are, first, that utility-enhancing government spending mitigates the impact of a fiscal shock on the real exchange rate, issue that did not arise in the PCP framework. Second, as mentioned earlier, utility-enhancing government spending also mitigates the effect of a fiscal shock on the international distribution wealth.

3.3 Temporary Government Spending Shocks

Figures 5 and 6 display the effects of a temporary Home government spending shock, in the case where government spending does not affect productivity or private utility. One striking feature of the responses is that a temporary fiscal shock causes remarkably identical effects on both countries. A visual inspection of Figure 5 suggests that the correlation of Home and Foreign output is much higher than in the case of a permanent fiscal shock. The correlation of Home and Foreign output rises since a fiscal shock now increases demand for imports at almost fixed relative price of imports in terms of Home currency.[10] And because the effect of the higher tax burden on labour supply is fairly small.

Several other observations are in order. First, the effect of a temporary fiscal shock on the bond holdings of Home households is relatively high. The

[10] This finding is slightly different from Betts and Devereux (2000). If all prices are sticky and output is demand-detemined in the short run, then a fiscal shock raises demand for imports at the fixed relative price of imports in terms of Home currency. In this case, "both home and foreign output must rise by equal amounts" (Betts – Devereux 2000, 235).

induced wealth changes via current account imbalances have real effects that last for all time, albeit the magnitudes are small. Second, the impact of a temporary fiscal shock on the nominal and real exchange rate and the terms of trade is very small. Third, the time paths of the real exchange and the terms of traded are identical to ones found in the case of a permanent fiscal shock. Four, Panels (b) in Figures 2 and 6 highlight that the qualitative response of the Home nominal wage to a fiscal shock immediately after the shock is dependent on whether the shock is permanent or temporary.

3.4 Exchange Rate Fluctuations: A Sensitivity Analysis

As noted by Lane (2001, 261), many predictions of the theoretical NOEM models are sensitive to the choice of parameter values. To complement the quantitative analysis we conduct a sensitivity analysis to investigate to what extent the effects of fiscal permanent shocks are sensitive to the calibration of two key parameters: the consumption elasticity of money demand and a measure of firms that sets new prices each period. In the sensitivity analysis, we consider the case in which government spending is pure waste.

3.4.1 The Consumption Elasticity of Money Demand

As illustrated by Obstfeld and Rogoff (1996) and Betts and Devereux (2000), the consumption elasticity of money demand is a key variable in determining the nominal exchange rate response to economic shocks. Therefore, we now analyze how changing this elasticity affects exchange rate dynamics and the transmission of fiscal policy. Since Mankiw and Summer's (1986) estimates of the consumption elasticity of money demand are very close to unity, we now set $\varepsilon = 1$. Figures 7 and 8 display the dynamic effects of a fiscal shock under the two cases considered.

As above, the nominal exchange rate depreciates because the relative consumption change lowers the relative demand for Home money. Panel (c) in Figure 7 shows a once-and-for-all depreciation of the nominal exchange rate of just less than 0.6 percent. As shown by Obstfeld and Rogoff (1995), the lower the consumption elasticity of money demand is the less the nominal exchange rate depreciates. The panel highlights that the effect of a fiscal shock on the nominal exchange rate is now drastically greater than in the baseline case. If exchange rate fluctuations are measured by the impact of the shock, then a low consumption elasticity of money demand reduces nominal exchange rate fluctuations, notwithstanding exchange rate overshooting. In addition, Panel (d) demonstrates that a higher deprecation of the nominal exchange rate translates into a higher real depreciation.

The higher nominal exchange rate depreciation has several implications for the transmission of fiscal policy. As above, the main economic effects of the exchange rate depreciation are on the revenues of firms. In this case,

the depreciation redistributes incomes by much more than in the benchmark case. The reduction in the revenues of Foreign firms lowers Foreign consumption, even though Foreign output increases. A rise in Home government spending, therefore, tends to produce a positive cross country comovement of consumption immediately after the shock.

As noted by Obstfeld and Rogoff (2000), if prices are temporarily sticky in the importing country's currency, then unexpected currency depreciations can be associated with improvements of the terms of trade, contrary to the customary presumption. Panel (f) in Figure 7 displays that the nominal depreciation induces an improvement in the Home terms of trade immediately after the shock. The Home currency price of paid for goods imported from abroad and the Foreign currency price of goods exported abroad are almost fixed, however, an exchange rate depreciation raises export prices measured in Home currency [recall equation (4)]. A fiscal shock, therefore, causes an improvement in the Home country's terms of trade. As prices are adjusted, the influence of a fiscal shock on the terms of trade is reversed.

3.4.2 Varying the Degree of Price Stickiness

In this section, we examine to what extent sluggish price adjustment affects exchange rate dynamics. A reason to do this is that in this model, as in Dornbusch (1976), the overshooting of the nominal exchange rate derives from differential adjustment speeds in goods and asset markets. Therefore, the speed of price adjustment has important implications for exchange rate dynamics.

To show how the degree of price stickiness affects exchange rate dynamics and consequently fiscal policy transmission, we set the fraction of firms that change their price each period to 0.2. This implies that the average interval between price changes for a given firm is 5 periods and hence prices become more sticky. Figure 9 displays the macroeconomic effects of a fiscal shock, maintaining the assumption $\varepsilon = 9$. Note that the number of periods shown is increased to 15.

Figure 9 shows that decreasing the degree of price flexibility increases exchange rate fluctuations in two respect – exactly as should be expected. First, the higher the degree of price stickiness is the more the nominal and real exchange rate depreciate. Second, the higher the degree of price stickiness is the larger and more persistent the overshooting of the nominal and real exchange rate is. This is consistent with Dornbusch (1976) who show that the magnitude and persistence of exchange rate overshooting is inversely related to the speed of adjustment of prices.

One common result of the sensitivity analysis is that the qualitative responses of the variables are robust to changes in parameter values. Exceptions are the responses of the terms of trade and Foreign consumption in the short run. The sensitivity analysis also illustrates that the quantitative

effects of fiscal policy on the international distribution of wealth and the nominal and real exchange rate are sensitive to parameter values.

4 Conclusions

Virtually all NOEM models, that address fiscal policy issues, can be criticized for the assumption that government spending is pure waste. The present paper develops a model in which government spending can affect productivity and utility. Then we use the model to analyze the international transmission of fiscal policy. The main point of this paper is that of studying the consequences of productive government spending on the international transmission of fiscal policy. We show that the introduction of productive government spending tends to have positive effects on domestic consumption and output, but it also has a positive effect on foreign consumption. We demonstrate that productive government spending mitigates the impact of fiscal policy on the nominal and real exchange rate. In addition, productive government spending reinforces the international distribution of wealth and the deterioration in the terms of trade.

The assumption of non-productive government spending, a standard assumption in the NOEM literature, leads to an underestimation of the effectiveness of fiscal policy. On the other hand, if government consumption is a substitute for private consumption, the assumption of pure waste leads to an overestimation of the effectiveness of fiscal policy. The main conclusion of this paper could be that in assessing the international effects of fiscal policy it is important to take into account the composition of public expenditures. The identical point is made by Ganelli (2005) who show that the international effects of fiscal policy in the Obstfeld-Rogoff model are quite different if one assumes complete home bias in government spending.

This model assumes that all firms set prices in the local currency of the buyer and thus the degree of exchange-rate pass-through to import prices is zero. This assumption, of course, does not match reality exactly. On the other hand, the findings of Betts and Devereux (2001) suggests that the international effects of fiscal policy are not especially sensitive to the currency of export invoicing. This suggests that the main results of this paper would not change much if we assumed prices to be sticky in producers' currencies. Anyway, an interesting extension would involve the optimal invoicing choice along the lines of Devereux et al. (2004) and Bacchetta and van Wincoop (2005). Then the model would feature endogenous exchange-rate pass-through as firms could choose the currency in which they set their export prices.

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Figure 1: Productive government spending – the impulse responses to an unexpected permanent rise in Home government spending

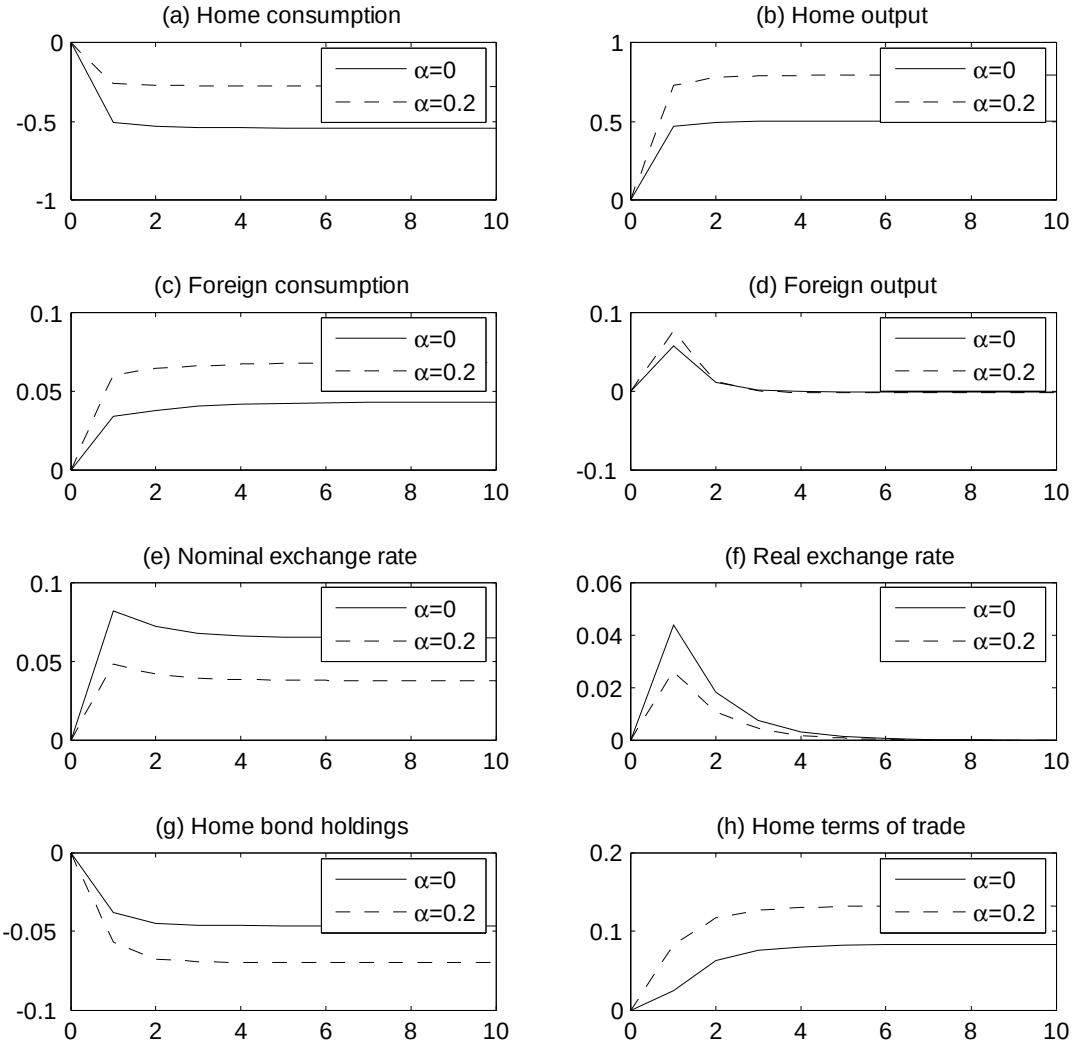

Figure 2: The impulse responses to an unexpected permanent rise in Home government spending, $\alpha = 0$

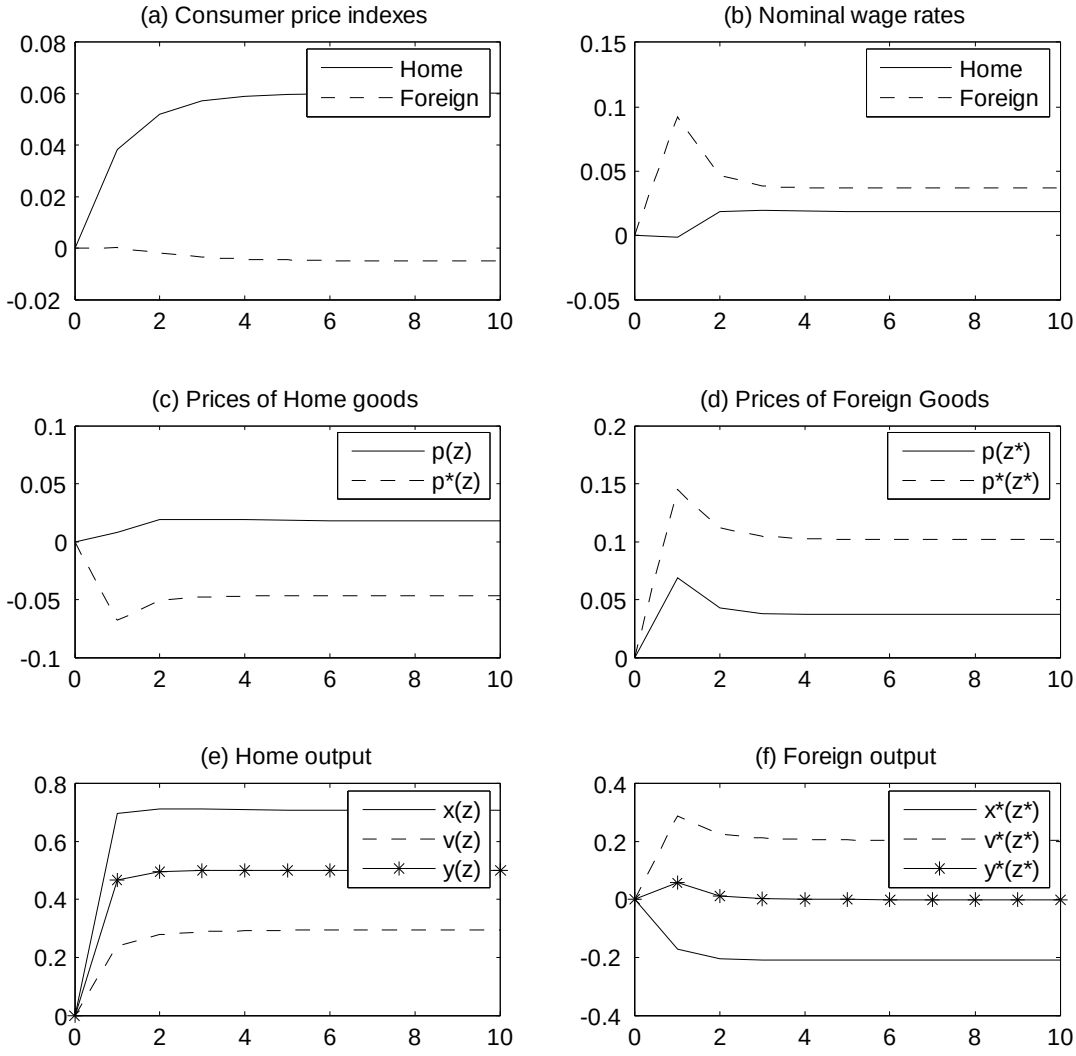

Figure 3: The impulse responses to an unexpected permanent rise in Home government spending, $\alpha = 0.2$

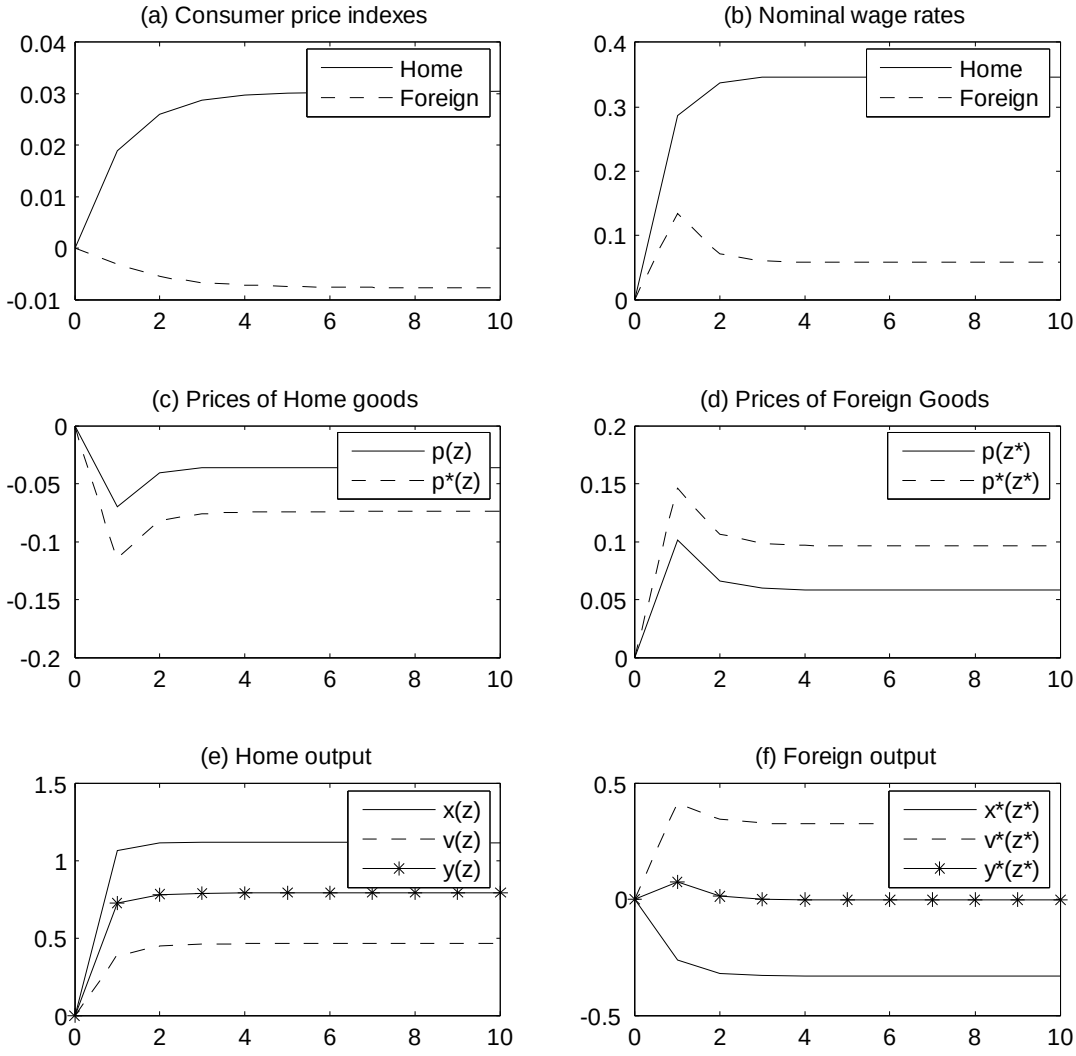

Figure 4: Utility-enhancing government consumption – the impulse responses to an unexpected permanant rise in Home government spending

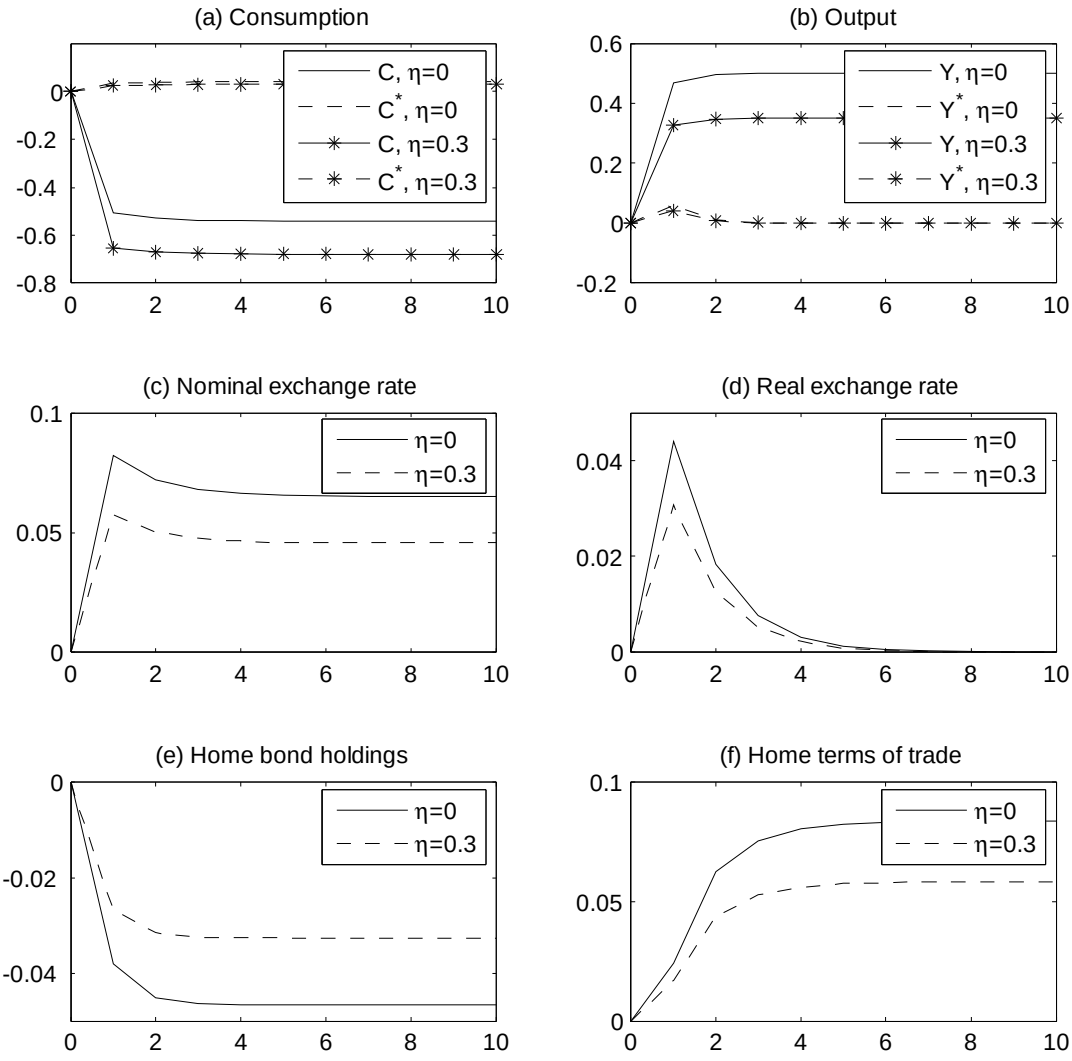

Figure 5: The impulse responses to an unexpected temporary rise in Home government spending ($\alpha = \eta = 0$)

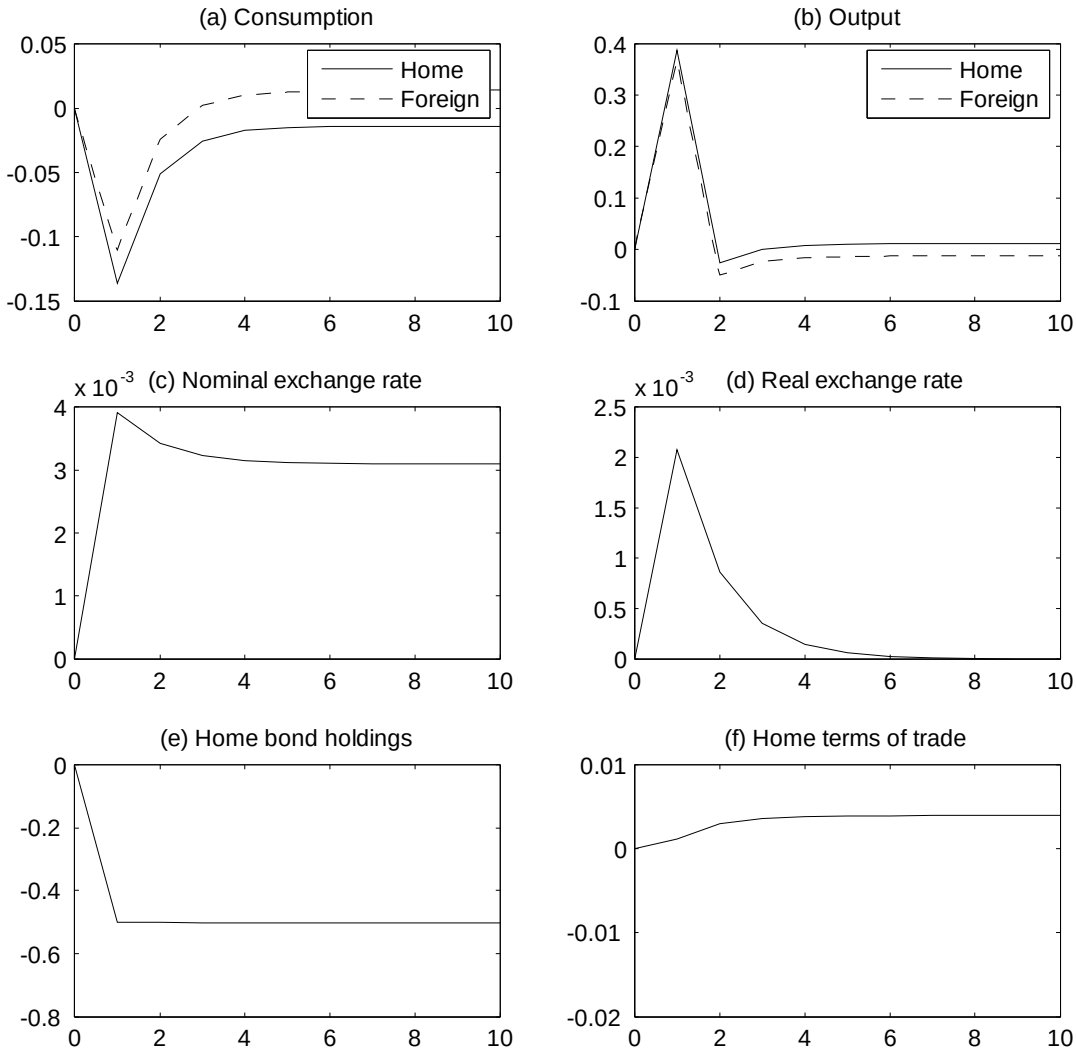

Figure 6: The impulse responses to an unexpected temporary rise in Home government spending ($\alpha = \eta = 0$)

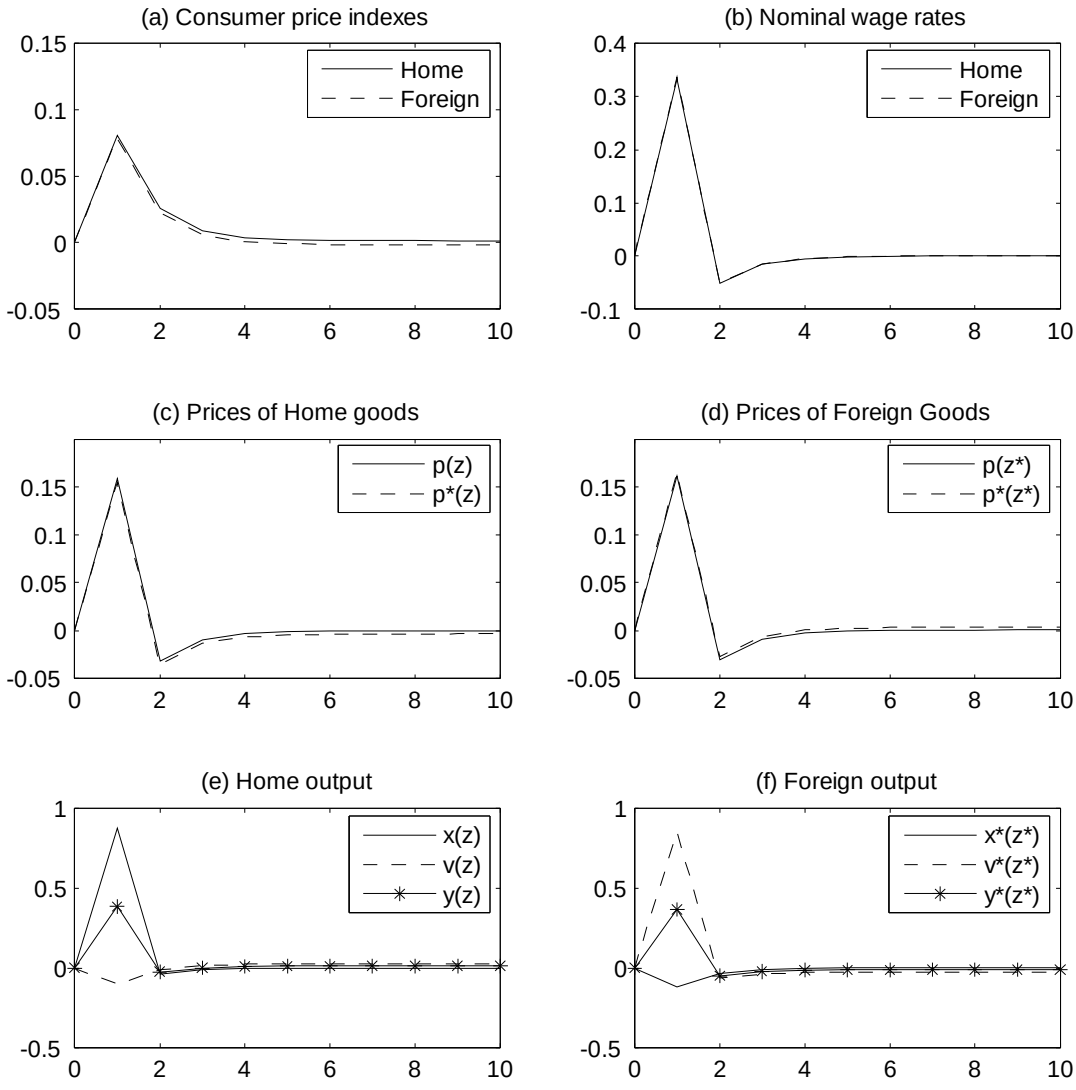

Figure 7: A sensitivity analysis – the role of the consumption elasticity of money demand. The impulse responses to an unexpected permanent rise in Home government spending ($\alpha = \eta = 0$)

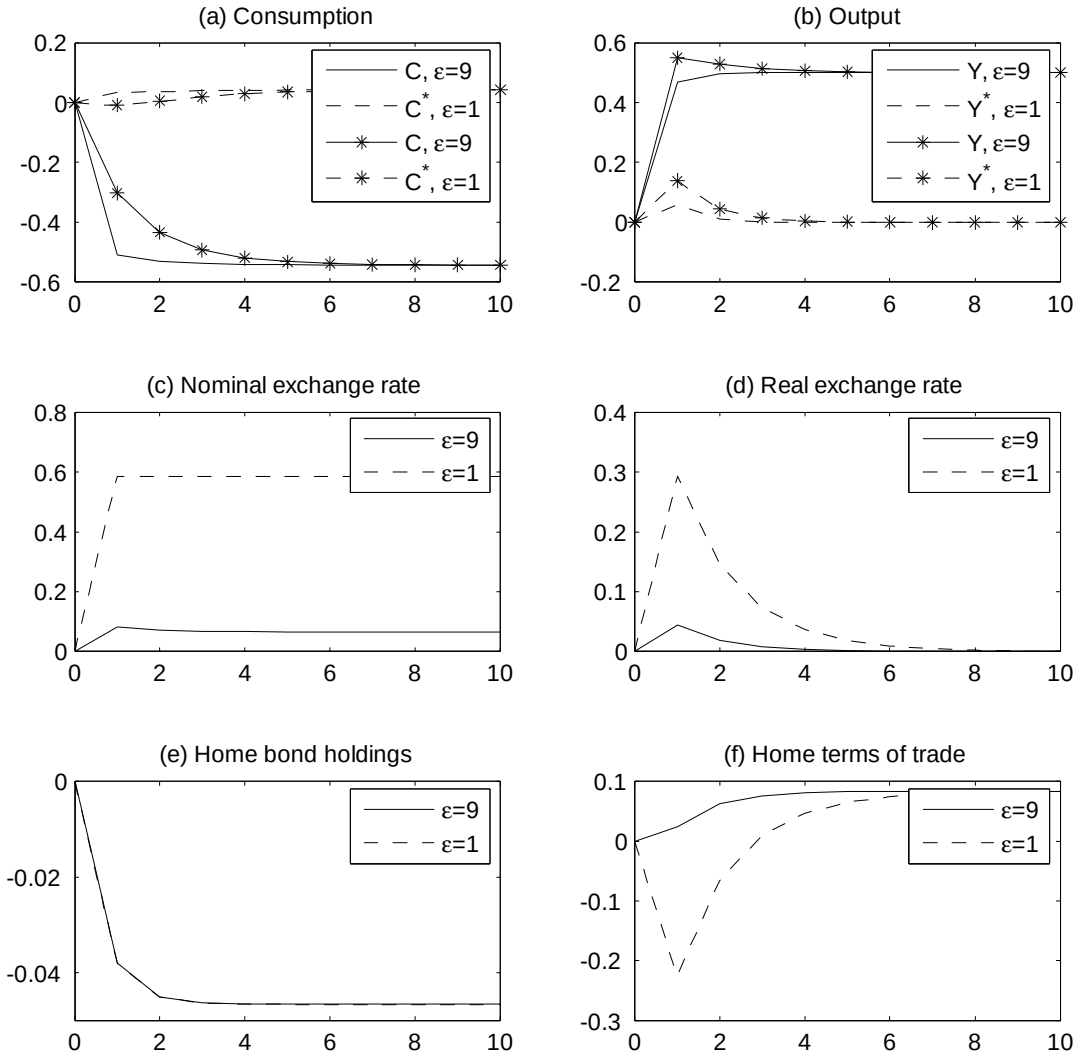

Figure 8: A sensitivity analysis – the role of the consumption elasticity of money demand. The impulse responses to an unexpected permanent rise in Home government spending ($\varepsilon = 1$ and $\alpha = \eta = 0$)

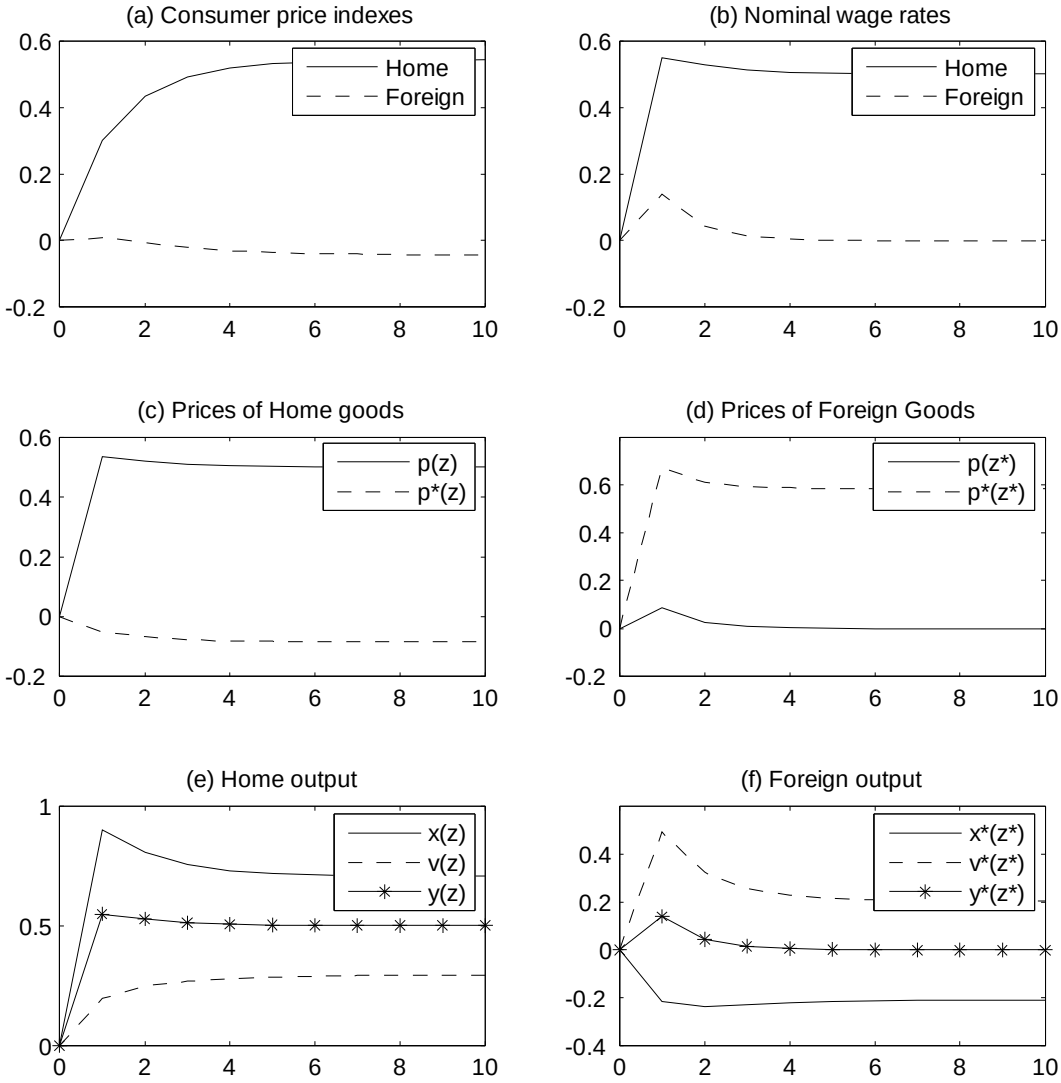

Figure 9: A sensitivity analysis – varying the degree of price stickiness. The impulse responses to an unexpected permanent rise in Home government spending ($\varepsilon = 9$ and $\alpha = \eta = 0$)